Lichen uncialis [Cladonia uncialis, *Hffm.*]. Rocks and heaths.
Lichen varius [Lecanora varia, *Ach.*]. Old pales.
Lichen venosus [Peltigera venosa, *Hffm.*]. Near Ludlow (Dr. Babington).
Lichen vernalis [Lecidea vernalis, *Ach.*]. Walls.
Lichen vespertilio [Collema nigrescens, *Ach.*]. (See *nigrescens.*)

XXVII.—*On the* Spongiæ ciliatæ *as* Infusoria flagellata; *or Observations on the Structure, Animality, and Relationship of* Leucosolenia botryoides, *Bowerbank.* By H. JAMES-CLARK, A.B., B.S., Professor of Natural History in the Agricultural College of Pennsylvania.

[Continued from p. 142.]

§ 4. *Bicosœca lacustris*, n. sp. Pl. V. figs. 33, 33ª, 33ᵇ, 33ᶜ.

This species lives in quiet streams and lakes, attached to filamentous Algæ, and is quite common, especially on old specimens of *Zygnema*. It is tinged throughout with a yellowish colour, which seems to add a good deal to the difficulty of distinguishing its various parts. When protruded (fig. 33), it occupies the anterior half of the calyx (*c*) and projects a little beyond its edge, and consequently its retractor ligament (*r*) stretches over the whole posterior half of the dormitory. The shape is rather elliptical than elongate-oval; but it varies more or less between these two forms, and seems to have the latter shape in the largest individuals. Posteriorly the body is rounded; but its broadest region is about the middle, and from thence it tapers considerably to a truncate front, and ends on one side in a laterally projecting *flagellum* (*fl*), and on the opposite side in a long incurved *lip* (*lp*).

The longitudinal furrow (r^1), which is so conspicuous in *B. gracilipes*, is much narrower in this species, and not so deep; yet it holds exactly the same relations to the base of the flagellum (*fl*) and the contractile ligament (*r*). After a number of observations upon the frequent and sudden retraction of the body to the bottom of its calyx, during which in every instance that side along which the furrow (fig. 33ᶜ, r^1) runs was contracted much more than the opposite one, I feel quite confident that this sulcus is the seat of a highly contractile band, and moreover that it is continuous with the posterior retractor ligament (*r*). The latter is very slender and thread-like, and is attached to the posterior end of the body on one side (see fig. 33ª, *r*) of its axial line, and has very much the appearance of being a free continuation of a ligament in the furrow just mentioned. The *lip* is nearly twice as long in proportion to the breadth of the front as that of *B. gracilipes*, and has an incurved digitate form (figs. 33, 33[a], *lp*).

The *flagellum* (*fl*) is the most remarkable and distinguishing feature of this species, when contrasted with *B. gracilipes*, on account of the wide angle at which it diverges from the longitudinal axis of the body; for whilst in the latter it deviates but little from parallelism with the axial line, in the former it arises at an angle of from forty to forty-five degrees (fig. 33[a], *fl*) with the same line. At its base it curves away from the lip, but for the remaining four-fifths it bends with a long arch in the opposite direction, but not so much as to bring its tip in a line with the body. It is therefore altogether eccentric; but yet its curve lies in the same plane relatively to the mouth and lip as that of its marine congener. Its length is about two and a half times that of the body; and it scarcely, if at all, tapers from one end to the other. It usually is held in a rigid attitude, except at the tip, which is always kept in a rapidly gyrating state, accompanied frequently by spasmodic incurvatures, when floating particles are thrown by it towards the mouth (*m*). Its flexibility is exhibited during the frequent spasmodic retrocessions of the body (fig. 33[c]), in the same way as in the other species; and the like remark applies to its action when assisting the lip to force the food into the mouth.

The *mouth* (*m*) opens in a slight hollow which lies between the base of the flagellum on one side and the lip on the other, and therefore is concentric with the longitudinal axis of the body. It very readily takes in quite large particles (fig. 33, *m*) of food, with the aid of the incurvating lip (*lp*) and the flagellum (*fl*), and immediately encloses them in a digestive vacuole, or, more properly speaking, a hyaline envelope, within which they revolve for a while with considerable rapidity. The *anus* (fig. 33, *a*) lies in the same hollow as the mouth, but further up on the base of the lip. That it is distinct from the mouth was frequently demonstrated by the collection of large globular masses in the base of the lip, and sometimes further up, and their subsequent exit thereabouts.

The *two contractile vesicles* (*cv*, *cv*) form another very strong mark of distinction, since they are not only double the number of that of *B. gracilipes*, but are also situated at the extreme posterior end of the body. They are quite conspicuous, and appear to lie right and left of the plane which passes through the lip, flagellum, and furrow. The systole of each alternates with that of the other, and occurs from five to six times in a minute, but with nothing remarkable in its action, unless it be that it operates more moderately than in *Monas*.

The *calyx* (*c*) has, in its fully developed condition, about the same shape and proportions as that of the marine form (figs. 34, 35), but, like the body, it is much larger. In its younger stages (figs. 33^a, 33^b, 33^c, *c*, c^1) its aperture (c^1) almost closes when the body is retracted (fig. 33^c), and during the protrusion of the latter its rim (fig. 33^a, c^1) embraces it very closely, so that on the whole the calycle has an elongate-ovate shape, with a narrowed, truncate, smooth margin. During the undeveloped stages of the calyx, the *pedicel* (*pd*) is less than half its length, and from that it varies down to little (figs. 33^a, 33^c, *pd*) or nothing; but when the former is full-grown (fig. 33, *c*) the latter (*pd*) is at least half as long as it. It is more slender than that of *B. gracilipes*, and, like the latter, is attached to the base of the calyx opposite to the insertion of the retractor ligament (*r*).

§ 5. Codonœca, nov. gen.*

Codonœca costata, nov. sp. Pl. V. fig. 36.

Of all the calyculate Flagellata, the species before us is perhaps by far the most beautiful, both in physiognomy and proportions. It is a marine form, and was found with *Bicosœca gracilipes*. Generically it differs from *Bicosœca* (§§ 3 & 4) in having neither a basal retractor muscle, nor lip, nor lateral longitudinal furrow, and by the attachment of its single flagellum (*fl*) to the central point of the front. From *Salpingœca* (§§ 7, 8, & 9) it differs principally in not possessing a projecting collar or rim about the anterior end; but, as in that genus, the body is not attached to the calyx by any visible means. It cannot be a *Dinobryon*, since that, as Claparède has already shown, has but a single contractile vesicle, and, moreover, it is situated near the anterior end of the body, and just behind a red eye-spot. *Dinobryon* has a slightly notched asymmetrical front; in fact it is a calyculated Euglenian. The general tint of the body of *Codonœca costata* is a dingy yellow, whilst the calyx (*c*) is colourless and excessively transparent. The shape of the body is oblong, rounded posteriorly, and slightly pointed in front, where the flagellum (*fl*) is attached. Its posterior half nearly fills the basal third (c^2) of the calyx.

The *flagellum* (*fl*) has not that rigid carriage which is so characteristic of that of *Bicosœca* (§§ 3 & 4) and *Anthophysa* (§ 11), but is a truly vibratile organ. It is kept in an almost constant state of rapid agitation, and projects at the same time far beyond the rim (c^1) of the calyx. It is by no means easy

* κώδων, a bell; οἰκέω, to inhabit.

to detect, even with a power of eight hundred diameters, not only because it is seldom at rest, but on account of its excessive delicacy; yet when it does stop its vibrations, its character and proportions can be unequivocally demonstrated under the proper circumstances of illumination and adjustment. It is about twice as long as the body, and has a decided although not rapid taper at its distal termination.

The *mouth* remains yet to be discovered. There can be no doubt, however, that it is an aperture of no very small extent, or at least that it is capable of considerable distention, inasmuch as we find quite large angular particles within the body. That it is terminal rather than lateral, is probable from the similar position of this organ in the not very distantly allied genus *Codosiga* (§ 6).

The two *contractile vesicles* (*cv*, *cv*) are situated midway between the front and hind ends of the body, and at two nearly opposite points. They are of moderate size, yet not so large as those of *Codosiga* (§ 6), which they resemble, but exhibit a much feebler action than the latter.

The *calyx* (c^1 c c^2), or carapace so called, has an ovate-campanulate outline, but is divided by a constriction into two regions. One of these, the basal (c^2) or posterior third, is about one-half as wide as the remaining two-thirds (*c*), and possesses an ovate-obconical form, which tapers abruptly into the pedicel (*pd*). The anterior two-thirds (*c*) arises from the sharp constriction with a strong swell or bulging, and then, narrowing a little, terminates with a truncate aperture (c^1); so that on the whole this portion may be compared, in shape and proportions, to a claret-glass. This region is peculiar, moreover, in being longitudinally banded or sulcated by about twenty furrows, which terminate at the rim in as many notches, that alternate with a like number of distinct scallops. Of these two regions, the basal one is quite distinct, although perfectly hyaline; but the banded part is much fainter, and requires a careful adjustment of the light in order to bring it out clearly. The *pedicel* (*pd*) is moderately slender, colourless, at least as long as the calyx, and of a uniform thickness from base to top.

§ 6. Codosiga, nov. gen.*

Codosiga pulcherrima, nov. sp. Pl. V. figs. 7–27.

This infusorian is as eminently a compound Flagellifer as *Anthophysa* (§ 11), and, although not a heteronematous form (like the latter), it bears a very striking general resemblance to it, as one may see by comparing figs. 8 and 47 with each other.

* κώδων, a bell; σιγάω, to be silent.

It also frequents the same habitat as *Anthophysa*, where it is quite abundant, and readily recognized, when one has become familiar with it, even under as low a magnifying-power as two hundred diameters. The greater number of individuals are found attached singly (figs. 9 and 24^a) or in twos to a slender peduncle (*pd*); but often three or four constitute a colony. A group of these monads seated on their short pedicels (fig. 8, pd^2), and the latter arising from a nearly common point at the end of a long slender peduncle (fig. 8, *pd*), might be designated, in botanical parlance, as umbellate. Very seldom are more than four or five bodies assembled in one colony; but occasionally as many as eight (fig. 7) are united in a single umbel. They bear the same remarkable relation to each other and to the main stem (*pd*) that we find in *Anthophysa*: that is to say, the arcuate flagellum (*fl*) of every member of the group curves backwards towards the base of the common peduncle (*pd*); and consequently the rest of the organism of each one holds a corresponding position. When there are but three or four in a colony, the longer axis of each monad usually diverges at an angle of not more than thirty or thirty-five degrees from the axis of the main stem; but when the number is greater, the divergence is also greater, and frequently amounts to seventy or eighty degrees. Oftentimes it will be observed that several of a group of bodies are attached in pairs (figs. 21, 22) to the pedicels, instead of each being possessed of a support of its own. This, as will be explained more fully under the head of *fissigemmation*, arises from an incompleteness of the self-division of which the pairs are the several resultants; and it will be noticed also that they are smaller than those which arise singly from the common peduncle.

The usual *form* of the body is an oblique oval (figs. 25, 26, 27), which is twice as long as it is broad; but in old individuals which are about to undergo self-division, the shape is very broadly oval (fig. 24^a), and its one-sidedness is not very conspicuous. The same may be said of specimens which have lived for a while in stale water, and have lost nearly all their yellow colour (fig. 24). Posteriorly it tapers, more or less abruptly, into the pedicel (figs. 25, 26, 27, pd^2); but anteriorly it is slightly constricted (b^2) a short distance behind the front, and thence projects in the form of a low truncate cone (fig. 24^a, *fr*). From the constriction (b^2) there projects, in direct continuation of the epidermis of the body proper, a very high, *membranous, campanuliform collar* (b b^1), presenting on the whole an appearance as if the body were seated in the lower half of a deep urceolate calyx. That this collar is not the upper portion of an urceolus, in any sense of the term, may b demonstrated in two ways at least. In the first place, it is highly flexible and retractile, as it occasionally shows itself to be, either by narrowing its aperture almost to absolute closure (fig. 24, *b*), or by reducing its height to a small fraction of its greatest altitude (as seen in fig. 27, *b*), and then extending itself again, within a few seconds, by a direct protrusion (fig. 26, *b*), to its original proportions (fig. 25, *b*). In the second place, it divides longitudinally, like the rest of the body, when self-division occurs (figs. 11–22)—a process in which no genuine calycle was ever known to be concerned. In an adult state (figs. 8, 11, 24[a], 25) it is slightly constricted by a gradual incurvature extending from the base (fig. 24[a], b^2) to the distal margin (b^1); but frequently, and apparently always just before self-division takes place, its sides bulge slightly outward (fig. 11, *b*). Taking all these things into consideration, therefore, it is perfectly clear that this infusorian is not a calyculate form, but one of those mimetic shapes which occasionally deceive the eye and puzzle the observer, until he becomes familiar with their various phases of growth and development.

This phenomenon is most singularly exemplified by the creature before us now, in its almost indistinguishable resemblance to a genuine calyculate Flagellifer (*Salpingœca marina*, Pl. VI. figs. 28–32[a]) which abounds in our marine waters. This similarity arises chiefly from the fact that the urceolus (figs. 28–32, *c*) of the latter has an oval shape like the body of the former, and is constricted so closely at its aperture (c^1) as to present the appearance of being continuous with the high campanuliform collar (*b*) which projects from the front. Usually, however, the body proper of this animal (*Salpingœca marina*, nov. sp.) lies loosely within, and considerably withdrawn (fig. 28) from, the parietes of its calyx; but occasionally in older specimens it completely fills (fig. 31) its sheath; and then it is next to impossible to distinguish it, in this respect, from a *Codosiga*. In a sessile freshwater species of *Salpingœca* of the urceolate type (*S. amphoridium*, figs. 37–37[d]), the *resemblance* to *Codosiga* is almost as strong, but the *difference* is equally marked.

The *flagellum* (figs. 8 &c., *fl*) is the only prehensile organ which *Codosiga* possesses. It arises from the middle of the low truncate cone (*fr*) which constitutes the front, and consequently within the campanulate collar (*b*), reminding one of the curvate *style* of a labiate monopetalous flower. It is usually rigid, excepting at the tip, which is constantly occupied in throwing particles of various kinds toward the mouth (*m*) by vigorous spasmodic incurvations or jerks. At its basal half it is slightly curved towards the longer side of the body, but gradually reverses the arc and, assuming a much stronger bend in the opposite direction, terminates abruptly, and far beyond the edge (b^1) of the collar, with about the same thickness as at its base. It is a very conspicuous organ, and therefore its whole sigmoid length may be studied with any amount of detail that could be wished for. The plane of this sigmoid curve is a direct continuation of that which passes through the opposing longer and shorter curves of the obliquely oval body. Calling to mind now what has been said in regard to the direction of the curve of the flagellum of the respective individuals of the colony, it will be seen that if these planes are projected inwardly and downwardly, at the same time passing along the pedicels (fig. 8, pd^2) of each body, they will all meet at the main stem (pd).

Besides being used as an organ of prehension, the *flagellum* is occasionally devoted to other purposes,—for instance, to act as a scavenger by whirling in a gyratory manner, and thus clearing the area within the collar of fæcal matters which have been ejected from the anus at a point near to, or perhaps coincident with, the mouth (m). At other times it acts as an organ of propulsion during the act of natation (fig. 23), when one of the resultants of self-division breaks loose from the colony and seeks another point to settle down upon and secrete its stem. During this wandering life of the Monad it swims, at times very rapidly, with its basal end (fig. 23) preceding it in the direction of its course, and the *flagellum* (fl) following behind and vibrating in rapid undulatory and gyratory curves, as if it were the screw propeller of some subaqueous vessel.

That the *mouth* (figs. 23, 24, 24^a, m) is situated near the base of the flagellum (fl) is rendered certain by the fact that particles of food are thrown by that organ directly against the area (fr) upon which it is based, and are taken within the body somewhere in that region; but, on account of the minute size of these morsels, and the rapidity with which they are swallowed, it has not been possible to determine precisely at what point. The position of the *anus*, which, as I have already suggested, may possibly be coincident with the mouth, is easily determined, even to the narrowest limits, as the fæcal matter is discharged in large, highly refractile pellets (fig. 24^a, d) close to the base of the flagellum. The digestive vacuoles are quite conspicuous, and frequently very large; but they never have been observed to be so numerous as to obscure the view of the interior of the body.

The *contractile vesicles* (cv, cv) are two quite conspicuous globular organs, which lie close to the surface and in the posterior third of opposite sides of the body. Occasionally *three* (fig. 10, *cv*) of these vesicles are found together; but it has always been evident at such a time that the body was preparing for fissigemmation (figs. 9, 10), and that the increase in number of these organs arose from the fact that one of them had already undergone self-division. In another genus (*Salpingœca*, *S. marina*, nov. sp., figs. 28, 29, 30) no less than *four* contractile vesicles (*cv*) have been observed to arise from two, under the same circumstances.

The systole of each vesicle of *Codosiga* occurs regularly once in half a minute, and usually that of one alternating with that of the other. Both the systole and the diastole proceed very deliberately, each, however, not occupying more than a few seconds. During the interval between the end of the diastole and the beginning of the systole the vesicles have a rather irregular, indefinite, spheroidal outline; but just at the moment of systole they assume a sharply defined and perfectly globular shape, and raise the surface of the body into a quite perceptible bulge. During this momentary expansion a vesicle equals at least half the greatest diameter of the body.

The *reproductive organ*, if we are not mistaken in our interpretation, is seated at the posterior end of the body, behind the contractile vesicles. It is a globular, highly transparent body (figs. 23, 24, *n*), and sometimes almost fills the space on each side of it. That it is solid, and not a mere vacuole, appears conclusive from its resilient action after being indented by the expansion of the contractile vesicles. It should be mentioned that this body was not observed in the fresh specimens which were collected in December, but appeared to be constant in some stale examples which had been kept on hand for two or three months.

The *peduncle* (fig. 8, *pd*), or main support of the colony, and the pedicels (pd^2) or immediate bearers of the individuals, share in the general gamboge-yellow colour of the latter, and also in their vitality. The latter statement has been verified fully in regard to the pedicels, by seeing them split down to their bases after the body proper has undergone self-division; and in regard to the peduncle, although only one observation was made, and the splitting was followed in its slow course downward for only a short distance, it was evident, from its much more than usual thickness and the presence of a distinct median furrow which extended to its very base, that it eventually would divide into two stems. The length of the peduncle varies from a mere disk, when it begins to develope from the base of some newly settled Monad, to five or six times the length of an individual. It always carries a single body until it is at least three or four times its length (figs. 9, 24, 24[a]), and frequently much longer; but in the latter case it was sometimes observed to arise from the falling away of one of the resultants immediately after self-division occurred. It has a uniform thickness, or occasionally the slightest possible taper, from base to apex, and appears to be solid and homogeneous in texture. It is apparently inflexible, and, even when carrying a single body, is united to it at a sharp angle with the longer axis of the latter (fig. 24[a]).

Fissigemmation.—This is the only process of reproduction which has been observed. Several instances of this kind were partially followed through in an incidental way, and two complete courses were carefully noted and drawn within a half-hour of each other. The set of figures 13, 15, 17, 19, 21 relate to one individual, and figures 11, 12, 14, 16, 18, 20, 22 to another belonging to the same colony. The rate of progress of the former when the drawings were made was not noted; but that of the latter set was observed in four out of six of the intervals which occurred between the phases which the figures represent; and during the progressive steps of the latter it was carefully recorded which of the successive stages of the former filled the intervals between those of the latter; so that it can be said, in the strictest sense, that all the figures of both sets of observations represent the phases which were distinctly marked in the second series. In this way the fullest illustration possible was obtained, and no point was left unexplained. The whole time occupied by the process in the second series was *forty minutes*. It has already been mentioned, when describing the form of the collar, that it assumes a bulging campanulate outline (fig. 11, *b*) as a preparatory, preliminary act in fissigemmation. In addition to this, it should be stated that it widens inordinately at the distal end, so as to exceed by one-third its normal breadth; but before it finally settles itself into this shape and proportions, it contracts and expands its diameter by a peculiar sort of vibrating motion, and passes through a series of changes of form which vary from a funnel-shape to a narrower cylindrical outline, or from either of these to a broader cylindrical proportion,—such, for instance, as figures 9 and 10 (representing the same individual) exemplify. This would appear, also, to be the time when the contractile vesicles divide; for at no other period were they observed to be more than two in number, as they are represented in figs. 9 and 10 (*cv*).

Immediately after this preparatory sign was discovered (the time being noted at 12.55 P.M.), the flagellum became unusually conspicuous and much thicker, and moreover it lost its sigmoid flexure and assumed a perfectly straight carriage, with the slightest possible tremulous vibratory motion. Within a very few minutes after this, the flagellum began to shorten as if retracting, reminding one of the running down of a cotton-thread in the flame of a candle, and in one minute's time it became reduced (fig. 12, *fl*) to a length which was somewhat less than half the height of the collar (*b*), and then it rapidly disappeared and left no trace of its former position. During this process the body shortened and became broader (fig. 12) in the same direction that the plane of the arc of the flagellum formerly trended in, and consequently the contractile vesicles (*cv*) were more widely separated; and the front (*fr*) also having become proportionately extended laterally, the base of the collar (*b*) was also increased in diameter until it almost equalled that of the distal end, so that, as a whole, it was almost cylindrical.

In less than fifteen minutes after the preparatory stage was observed, the collar had become cylindrical (fig. 13, *b*) by a combined action of the base and distal end, which consisted in a narrowing of the latter and a broadening of the former.

It was not until 1.15 P.M. that a decided mark of incipient self-division became evident in the guise of a narrow, slight furrow (fig. 14, *e*), which extended, medianly, from the front to over halfway toward the posterior end of the body. By this time the body had broadened until it was wider than long, and the collar (*b*), having followed this expansion at its basal portion whilst its upper extreme had contracted a little, had assumed the form of a high truncate cone.

In two or three minutes after this, the body had become distinctly indented (fig. 15, e^1) at the anterior termination of the furrow (fig. 15, *e*), and the latter had grown longer and more distinct, whilst the collar (*b*) had approximated more closely in shape to a perfect cone.

In another minute or two the anterior indentation (fig. 16, e^1) had become so deep and broad that the body presented a cordate outline when seen from its broader aspect, whilst the furrow (*e*) appeared to extend to its base, and the distal end of the collar (*b*) had so nearly closed up as to give that body an almost completely conical form, with a slightly collapsed periphery.

From this moment the process of reduction ceased; and soon after, the cone-shaped collar began to expand (fig. 17, *b*). Consentaneously with this, the anterior indentation (e^1) had become sharper and deeper, and (with the lateral median furrow (*e*) of each of the opposing broad flanks of the infusorian acting in combination with it) had split the body about halfway to its base. The most remarkable phenomenon observable at this time was what occurred at the rounded ends of the two half-separated bodies of the new pair of individuals. This was no more nor less than the incipient development of the flagellum, which proceeded in this wise:—At each of the rounded ends just mentioned a slight commotion appeared, resembling the molecular vibrations of a granule; and then there arose quite rapidly a sharp and distinct filamentous outgrowth (*fl*), which kept itself in a constant state of narrow vibrations, or a sort of shivering.

By 1.23 P.M. the newly born flagella (fig. 18, *fl*) had risen to half the height of the collar (*b*), and still remained in a shivering condition, whilst the body had divided almost to its base, and the collar had broadened to a widely terminating truncate cone.

In about a minute more, the dividing process had risen into the collar and split it (fig. 19, e^2) upwards for one-quarter of its height; and the still tremulous flagella (*fl*) were slightly longer than in the last phase.

By 1.26 P.M. the body was divided (fig. 20) to its posterior termination, and the fissuration (e^2) of the collar (*b*) had reached halfway to the distal edge, and was further sketched out as it were by two opposing shallow longitudinal furrows, which extended to the margin. At this period the collar was broader at the still undivided portion than below; so that on the whole it had a very wide campanuliform shape, or rather (since the divided portion was rolled inwards at the opposing edges) was like two slightly flaring, broad funnels, merged into each other at their broader ends. The flagella (*fl*) also had developed considerably, and extended a short distance beyond the collar; and the front end of the body, from the middle of which the flagellum arises, had assumed the low, truncate, conical shape of the adult form.

From this time onward the division did not appear to go forward so rapidly; and the new bodies seemed to be more particularly occupied in shaping themselves into the characteristic form of the adult. The collar, however, was not long in dividing itself up to its margin (fig. 21), but still the two cylindrical halves (*b*, *b*) did not separate at their extremes as soon as the fission reached that point.

At 1.35 P.M. the self-division was completed (fig. 22), as far as the body proper was concerned, and had extended a short way down the pedicel (pd^2). The margins of the two collars (*b*) seemed merely to lie in contact; and each collar had a slightly funnel-shaped outline, and was considerably more elevated in proportion to its diameter than in the adult form. The flagellum (*fl*) was nearly as long as that of the full-grown body, but yet had neither the sigmoid curve of the latter nor its stout and rigid aspect, but was much more delicate, and in fact still exhibited a slight tremulous motion. The two contractile vesicles (*cv*) of each body were as distinct as those of the adult, and had the same proportionate size and relative position.

In a very few minutes the two resultants were totally separated and divergent from each other at a sharp angle; and in less than half an hour after the last time noted, they had assumed the proportions of the other members of the colony. Shortly after the investigation of the phase just described, the last stages of self-division of another body, belonging to the same colony, were observed; and thus the group, which within two hours before consisted of five individuals, was increased to eight (fig. 7). It seems to be a rare occurrence that so many bodies remain long together, since it very seldom happens that more than four or five (fig. 8) are found in a colony; and now and then, in such instances, I have seen an individual drop off and swim away. When we meet with them settled down upon some point, amidst others which have scarcely any stem and those which are seated on very short peduncles, it becomes perfectly clear that they are there for the purpose of secreting a new support from the posterior end.

§ 7. Salpingœca*, nov. gen.

Salpingœca gracilis, nov. sp. Pl. VI. figs. 38, 39.

The difference between this genus and *Codonœca* has already been pointed out. It might well be compared to a stemless *Codosiga* (§ 6) enveloped in a sheath. I have met with three quite diverse species of this genus, of which that under present consideration and another (*S. amphoridium*, nov. sp., § 9) are freshwater denizens, and the third (*S. marina*, nov. sp., § 8) is a marine inhabitant. *S. gracilis* (figs. 38, 39) was found upon only one occasion, and then in an old aquarium, which could not be said to be in a perfectly healthy condition, although its contents were by no means putrid.

The *body* is yellow, and has a cylindrical shape, about four times as long as broad, narrowed and rounded behind, and rounded-truncate in front. Like *Codosiga* it bears a filmy, membranous, colourless collar (*b*), which is attached to the extreme edge of the frontal area (*fr*), and rises to a height which is equal to two-thirds of the length of the body. The outline of the collar is generally cylindrical, and truncate at the distal end, but still is subjected to various degrees

* σάλπιγξ, a trumpet; οἰκέω, to inhabit.

of momentary change. Unless it be by means of the vibrations of the flagellum, there is no other immediate agent which can be supposed to move the body up and down in its sheath. There is no visible movement in itself, like creeping, to be observed; and moreover the body progresses so quickly, when changing its place in the calyx, that it becomes evident that it is not due to any reptant mode of transposition. When withdrawn (fig. 38) into the basal tapering portion of its calyx, the collar (*b*) does not extend beyond the rim (c^1) of the latter, but, on the other hand, the body occasionally moves so far in the opposite direction (fig. 39) that nearly the whole of the collar (*b*) projects outside of the dormitory.

The *flagellum* is a delicate filament which arises from the axial point of the front, and projects a short distance beyond the edge of the collar. It presents a constantly undulating aspect, and vibrates from base to tip.

The *mouth*, we are obliged to presume, as we did in regard to *Codosiga*, lies somewhere about the base of the flagellum. Abundant digestive vacuoles were observed, as well as loose particles of food, in various parts of the body; but at no time were we so fortunate as to see the introception of nutritive material or the ejection of fæcal matter.

The *contractile vesicles* (*cv*) are two in number. They lie between the second and posterior thirds of the body, usually on opposite sides, and close to the surface. In aspect and rate of systole they resemble those of *Codosiga pulcherrima*, but they are a little smaller in proportion to the size of the animalcule. Sometimes the protean changes of the body are so extensive as to throw the two vesicles into a line with each other in an antero-posterior direction; but they hold this position only temporarily, and soon return to their normal relations.

The *calyx* (c c^1 c^2) has the general shape and proportions of a champagne-glass, and appears to be hollow to the very bottom (c^2) of its pedicel-like inferior third. Anteriorly it is truncate, smooth, and flares (c^1) quite strongly. About the middle it bulges very sensibly, and thence tapers gradually into a slender posterior third (c^2), but expands again slightly as it terminates upon its place of attachment. It is colourless, excessively transparent, and exhibits considerable flexibility under the movements of the body, apparently having the consistency of a mere film.

§ 8. *Salpingœca marina*, nov. sp. (Pl. VI. figs. 28–32[a].)

The remarkable generic resemblance of this species to *Codosiga* has already (p. 193) been commented upon. It is very common, especially upon the marine Hydromedusa *Dynamena* *pumila*, Lamx., but is so excessively minute, and withal so transparent, excepting the body proper, that under a magnifying-power of five hundred diameters it appears to the casual observer like a mere globular speck. It was discovered when searching after specimens of *Codonœca costata* with a power of eight hundred diameters. Although sometimes met with in groups of forty or fifty, it always appeared single. In its general aspect it may be compared to an oval flask which is supported by a slender stem (*pd*), and has a broad funnel inserted in its mouth. Upon close inspection we find that the funnel (*b*) is a direct projection from the body (which hangs freely within the flask, $c\ c^1$), and is in no way connected with the latter.

The *body* proper has a dark fuscous colour, and consequently is quite conspicuous. It is mainly oval in shape, but is constricted anteriorly into a short thick neck (*i*), which terminates in a truncate front. It hangs quite loosely within the calycle (*c*), and usually at a considerable distance from its parietes; but at the mouth (figs. 31, 32, c^1) of the latter the neck (*i*) presses so closely against it as to seem, without the most careful scrutiny, to form a continuation with it. Occasionally, however, the neck narrows and retreats from the aperture of the calycle to such a degree as to allow a clear and unmistakeable view (fig. 32) of the relations of the former to the latter.

The *collar* (*b*), which has just now been likened to a funnel set in the mouth of the flask-shaped calyx, is most frequently seen in a very broadly expanded state (fig. 28, *b*), in outline resembling a low, obtuse-angled, truncate cone inverted upon the front of the body. It arises from the extreme circular margin of the head (*i*), and, widening to about twice the equatorial diameter of the calyx (*c*), terminates in a smooth edge at an altitude which is hardly equal to one-quarter of the width of its distal expanse. It is hyaline, and so extremely thin and filmy as to require the most careful manipulation of the light, even with so high a power as eight hundred diameters, in order to define its boundaries clearly. In its plasticity it is even more marvellous than that of *Codosiga*; at least it exhibits it over a far wider lateral range than the latter, and with equal rapidity in its changes. In a few seconds it narrows from its greatest expanse to the proportions of an obverted acute-angled cone (fig. 29, *b*), and at the same time assumes an altitude which is equal to the length of the body; and then, within an equally short period, it contracts into the form of a cylinder (fig. 30, *b*) whose height more than equals that of the calyx. These changes are carried on with the same peculiar vibrations as were noted in regard to *Codosiga*, reminding one of the glimmering outlines of the prongs of a tuning-fork when vibrating. When observed with a poorly defining lens, I can readily see that this phenomenon might be mistaken for the cone of light produced by the gyratory vibrations of a single filament, or for the bright *lumen* of a circular row of vibrating cilia. As regards the former category, it may be said that the flagellum is far more conspicuous than the collar, and may be seen clearly projecting in the line of the axis of the body, and vibrating after a manner of its own. As for the latter supposed case, one might be inclined to dismiss it without any scruple, upon the simple assumption that no flagellate infusorian can bear numerous cilia, were it not that I call to mind my own discovery of a flagellated animalcule (*Heteromastix*, figs. 70–74) of the heteronematous form, which is at the same time abundantly ciliated. I have therefore taken all possible pains to ascertain that this "*collar*" (figs. 28–32, *b*) is a genuine membrane, and not the similitude of one.

Occasionally individuals (fig. 32) were seen which bore an inverted conical collar (*b*) that remained, at least for a time, at an expansion and altitude equal to the breadth and height of the calyx (*c*). These were among the largest specimens found, and almost or altogether filled the calyx. Rarely were examples found which crowded the calyx so fully as to seem to bulge it out laterally. Figure 31 represents such an instance, in which the aperture (c^1) of the calyx is absolutely inseparable from the head, excepting that, knowing that it is not really continuous, one recognizes the line of demarcation by the abrupt change in the thickness of the seemingly uninterrupted membrane. This case is also remarkable, inasmuch as it at the same time furnishes us with an example of an enormously large, bulging, campanulate collar, nearly as broad as the most common and normally permanent form (fig. 28), and yet higher than it is wide. In all probability, judging from appearances, which in every respect remind one of the preparatory steps of fissigemmation of *Codosiga pulcherrima*, this individual is soon about to undergo self-division. Unfortunately the drawing was made at a time when the impending process could not be watched.

The *flagellum* (*fl*) is as highly flexible as that of *S. gracilis*, and very active throughout its length. It is attached to a more or less elevated axial prominence in the middle of the frontal area, and extends to a length which is at most not more than one-third greater than that of the body.

Regarding the *digestive organs* nothing can be said, excepting that dark irregular pellets and loose foreign material were abundant enough, and so irregularly scattered that they could not be looked upon otherwise than as nutritive matter.

The *contractile vesicles* (*cv*) are two or three globular bodies, which, in appearance, position, relative size, and rate of systole, may be compared with those of *Codosiga pulcherrima.* On one occasion (fig. 30) they amounted to four (*cv*) in number, and were arranged in pairs, one above the other.

The *calyx* (c c^1) usually has the form of a Florence flask, but with a very short, thick neck, which flares (c^1) slightly at the aperture. It sometimes, however, is slightly pointed at its base where it joins the pedicel (*pd*). When not filled by the head (fig. 32, *i*) of the animalcule, the neck and the sharp margin (c^1) of its aperture may be clearly distinguished from the collar (*b*) which rises just above them; but very frequently this discrimination is attended with a good deal of difficulty, because when the body presses closely at this point, it overlaps the margin in question, and obscures it. The pedicel (*pd*) is not much longer than the calyx, and joins the latter with little or no expansion. It is colourless like the calyx, moderately slender, of a uniform diameter from top to bottom, and appears to be solid and homogeneous in texture. Figure 32^a represents one of three bodies which were found in the midst of several living animals of this species, and which had every appearance of being the deserted calycles of the same, with a collapsed aperture. In the next species (*S. amphoridium*) the deserted calycles (fig. 37^c) were found so numerous among those which were occupied, and moreover retaining the shape of the latter so perfectly, that there could be no doubt that the calyx is not only a separate organism apart from the body-wall, but also may be as readily vacated as that of *Cothurnia* or *Vaginicola.*

§ 9. *Salpingœca amphoridium*, nov. sp. Pl. VI. figs. 37–37^d.

Although this species bears a strong resemblance to *S. marina* (§ 8), there are several prominent points of difference between the two. *S. amphoridium* is a freshwater form, and appears especially to frequent old specimens of *Zygnema* and other filamentous Algæ. It is very common in such places, and lives in more or less crowded groups. Excepting the main part of the body, it is very transparent, but not so faint as *S. marina.* It varies much in size, even down to half that of fig. 37^a. Like its marine congener it always occurs single, and never with a trace of a pedicel to the calyx (c c^1). As a compensation for this, if one may use the expression, it has a long neck, which is frequently seen bending from side to side (fig. 37^b, *i*) with a gentle motion, and apparently in search of something.

The *body* is grey or greenish yellow in colour, which fades in the neck (*i*) and disappears altogether in the collar (*b*). In its general aspect the body with its collar might be compared to a wine-glass with a long stem and a globose pedestal. The globose part is the posterior half of the body; and the stem is its neck, or anterior half, which tapers rapidly from the main part to one-quarter or one-fifth its diameter, and then gradually widens to nearly double that thickness at its front, where the collar is set on. The *front* is truncate, or rises into a low cone, upon which the flagellum (*fl*) is based. The posterior half of the body usually fills the bottom of the calyx (*c*); but the rest and the neck (*i*) stand off from it at a very appreciable distance. In this respect there is a marked difference between this species and *S. marina* (§ 8). In the latter we might say that the body is suspended from the aperture of the urceolus; but in the former it rests on the bottom of the calycle. Not unfrequently, however, the whole body of this species lies loosely within its calyx (fig. 37).

The *collar* (*b*) is an excessively hyaline, filmy membrane, whose distal margin is so extremely delicate as to almost defy detection with the highest powers. In the latter respect it is a more difficult object of research than that of *S. marina*. Generally speaking, it may be described as obconical, but with greatly varying degrees of width. In this relation it agrees perfectly with that of *S. marina*, and therefore need not be redescribed here. At its greatest height it equals that of the body, and always terminates in a smooth edge. In plasticity it is also equal to that of the marine species. In one instance, when the animal was disturbed by a predaceous Rotifer, its whole body quickly retracted, and the collar totally disappeared, as if melted down with great rapidity, but soon after protruded slowly, at first with a broad base (fig. 37^{d}, *b*), and then rapidly narrowed at the latter point and assumed its usual proportions.

The *flagellum* (*fl*) differs from that of *S. marina*, both in proportions and deportment. It is usually rigid, and projects considerably beyond the collar when the latter is at its greatest height. It has a decided arcuate figure, with a uniform thickness throughout, excepting near the base, which tapers rapidly from the low cone in the middle of the front. Its apex moves with quite gentle spasmodic twitches, and the whole becomes flexible (fig. 37^{b}, *fl*) when fæces are ejected or some undesirable particle enters the area within the collar.

The *mouth* was not actually seen; but that it exists somewhere about the base of the flagellum was sufficiently demonstrated by minute particles of food being seen thrown by the latter organ against the front, and rapidly disappearing there. The *anus* (fig. 37, *a*) certainly opens within the same area, as particles of considerable size were seen to make their exit at the base of the flagellum. No digestive vacuoles were noticed, although the body was often found filled with food.

The *contractile vesicles* (*cv*) usually amount to three or four, and rarely to five in number; or there are two very large ones, which occupy nearly the whole breadth of the body (fig. 37^{a}). They occur in all parts of the body except its neck, and beat with a sluggish systole about at the same rate as those of *Codosiga* (§ 6).

The *calyx* (c, c^1) has very much the same proportions as the body, over which it is fitted as if upon a mould. Its posterior half (c) is globular, and is attached at its hindermost, axial termination to the point of support. Although hundreds of specimens of this species were observed, not one of them had a pedicel. The anterior half tapers, like the thick neck of an urn, from the posterior one to one-third of its diameter, and then rapidly widens and terminates with a flaring, smooth-edged aperture (c^1), which is about twice as wide as its narrowest portion. The margin usually is exceeded by the projecting head, so that the former may be seen quite readily as a distinct ring behind the circular edge of the front, from which the collar rises. The empty calycles (fig. 37^{c}) were found very frequently, and so nearly identical in form with those of the living body that they must have possessed considerable rigidity. That they are, however, to a certain extent flexible and plastic, was shown on one occasion, when the body and neck suddenly retracted and swelled laterally (fig. 37^{d}) to an extent which was considerably beyond the usual breadth of the calyx and its neck, and then returned to its former shape and proportions.

§ 10. *Leucosolenia* (*Grantia*) *botryoides*, Bowerbank. Pl. VI. figs. 40–44; Pl. VII. fig. 64.

If I were now to describe merely the congregated Monads of this compound animal without giving it a name, any one who had already become acquainted with the structure of *Codosiga* (§ 6) would set down the first as a colonial, massive form of the latter. In fact a glance at a figure of a free-swimming individual (fig. 23) of *Codosiga* in one of its numerous attitudes, and then a momentary inspection of the monad (figs. 42, 43, 44) of this Sponge would almost induce one to believe that the two belonged to the same genus, nay, even to the same species, as far as the representations referred to are concerned.

In the introductory section of this memoir I have already discussed the theory of Carter as to the alliance of Sponges with Rhizopods, and I will therefore only state here my firm conviction that the true ciliated *Spongiœ* are not *Rhizopoda* in any sense whatever, nor even closely related to them, but are genuine, compound *flagellate Protozoa*, and are most intimately allied to such genera as *Monas* (§§ 1, 2), *Bicosœca* (§§ 3, 4), *Codonœca* (§ 5), *Codosiga* (§ 6), and *Salpingœca* (§§ 7, 8, 9). What are the special relationships of the numerous genera of Sponges I am not prepared to say; yet, in regard to *Leucosolenia botryoides*, there can be no doubt that it is very closely allied to *Codosiga* and *Salpingœca*; but to which one more than to the other would be difficult to determine. *Codosiga* (§ 6) is a compound form like *Leucosolenia*, and its individuals are united by a common branching support, which has been shown, by the changes which it passed through during fissigemmation, to be as fully alive as the glairy, spicule-secreting cytoblastema of the Sponge. *Salpingœca* (§§ 7, 8, 9), on the other hand, is a single monad, but excretes around it an envelope, or *calyx*, into which the body is sunken in the same way that the monads (fig. 41, *md*) of the Sponge are imbedded in the surface of their common dormitory. Inasmuch, however, as the calyx is probably an excretion rather than a secretion, and appears as inanimate as that of *Cothurnia*, *Vaginicola*, and other Vorticellidæ, it is more comparable to the *spicula* (*sp*) than to the *cytoblastema* of Sponges. If one may draw an inference from the above considerations, it does not seem at all improbable that hereafter we shall find that the monads of the different genera of Sponges resemble the various genera of single and branching Flagellata; and then we shall be able to divide the former into such family groups as Monadoidæ, Bicosœcoidæ, Codosigoidæ, Anthophysoidæ, &c. &c.

Leucosolenia botryoides, Bowerbank, occurs on our sea-shore among the groups of *Dynamena*, *Sertularia*, &c., and may be readily recognized by its ivory-white colour. The colony is an elongate mass, seldom exceeds an inch or an inch and a half in length, and resembles an irregular group of slender contorted spines or forked horns (fig. 40), which vary in thickness from one-thirtieth to one-sixteenth of an inch in diameter. At the tip of each horn is an aperture, the so-called excurrent orifice, large enough to be seen by the unassisted eye. The whole mass is so transparent that not only the currents in the interior, but even the vibrating flagella and the pulsation of the contractile vesicles, may be seen with a strong light. The exterior consists of an excessively hyaline, cytoblastematous layer, with scarcely, if any, trace of organization of a cell-like character in it. Within this layer, or immediately beneath it, but certainly not in the monadigerous stratum, the faint yellow *spicula* (fig. 64, *sp*, *sp*[1]) are imbedded in systematic order, and overlap each other irregularly in two or three layers. They present two diverse forms—namely, a simple aciculate shape (*sp*[1]) and a stellato-triradiate (*sp*) one. The rays of the latter are slender, tapering frequently to a bifid termination, divergent at equal angles from each other, and lie in the same plane. Without exception they are all arranged with one ray (often longer than the others) projecting backwards, *i. e.* away from the excurrent orifice, and the other two extending symmetrically right and left, and obliquely transverse to the longer axis of the branch. In this manner they are disposed in a sort of network over the whole colony, even close up to the excurrent orifices; and as the aciculate spicula lie parallel with the rays of the other kind, there are consequently no projecting spines specially devoted to guarding the entrance to these apertures.

The *ostioles* (fig. 64, *o*), or incurrent channels, are very numerous, there being at least two, and often three, opposite to every interstice of the spicula. They are very small, but quite conspicuous, especially at their inner ends, where they plunge through the monadigerous layer (*md*). They afford great assistance whilst studying the contractile vesicles and the action of the flagella, since they enable one to get a freer view of the monads in an undisturbed state than where they are observed through all the tissues. It should be mentioned, however, in this connexion, that the profile view (fig. 41) of the monads was obtained by making an actual section of one of the younger branches and allowing it to revive and expand in a fresh supply of sea-water.

The *monadigerous layer* (figs. 41, 64, *md*) lines the cavity of the body; and it is by the combined action of the vibrating flagella (*fl*) of the monads that currents of water and floating particles are kept up. This layer is composed of monadiform animalcules (*md*), packed closely side by side in a vast colony, which extends over the whole length and breadth of the general mass. In this respect we are reminded of the similar arrangement of the individuals of that floating Ascidian, *Pyrosoma*. These monads crowd so closely upon each other that their sides are mutually compressed, and they thus form a sort of irregular polygonated pavement (fig. 64, *md*). They all lie with the anterior end (*fr*) turned inwardly and projecting into the general cavity, and the posterior extremity imbedded in the cytoblastematous, external, general envelope.

The *body* of a monad is yellow when seen by transmitted light, and in general terms may be designated as broadly oval, with the longer axis extending antero-posteriorly. Behind it is broadly rounded, at the sides lightly indented and irregularly polygonal by mutual contact with others, and extended in front into a delicate, membranous, circular collar (b b^1), which might be compared to a transverse section of a tube which is about as long as it is broad. This *collar* is capable of variations in form, like that of *Codosiga* (§ 6) and *Salpingœca* (§§ 7, 8, 9), at one moment assuming a truncate conical shape (figs. 43, 44, *b*), and in the next instant expanding its distal margin into a distinct flare (fig. 42, *b*) which is at least two-thirds as wide as the body; or, finally, it retracts altogether and disappears for a while, but eventually reappears and expands to its fullest dimensions*.

The *flagellum* (*fl*) is the only prehensile organ which the monad possesses. It arises from the middle of the frontal area, and extends to a great length, at least five or six times as long as the body, with scarcely any diminution in thickness. It is a comparatively thick filament, and quite conspicuous, on which account it is so easily seen through the whole mass of the colony. It usually vibrates with considerable vigour from base to tip, but occasionally assumes the quiescent state and arcuate form so eminently characteristic of that of *Codosiga* (§ 6), *Bicosœca* (§ 3), and others.

The *mouth* is the only organ which has not been actually observed, although its position has been inferred, not only from the otherwise similar structure of the monad of this creature to that of *Codosiga* (§ 6), but because currents of floating particles are constantly whirled in by the flagellum and made to impinge upon the area within the collar. In addition to this it may be added that more or less numerous coarse and fine particles (fig. 44, *d*) are always present and scattered irregularly about the interior of the monads, apparently under various degrees of digestive decomposition.

The *contractile vesicles* (*cv*) are two in number, and lie near

* In this connexion it may be well to mention the latest decision of Carter in regard to the structure of the monociliated sponge-cell. In the Annals and Magazine of Natural History, vol. xx. 1857, pl. 1. figs. 10, 11, this cell is represented as an oval body, with a single ciliary appendage; but in a subsequent communication to the same periodical (vol. iii. 1859, p. 14, pl. 1. figs. 12, 13, 14), a partial recantation seems to be made, and the cell in question is figured with "two spines or ear-like points projecting backwards, one on each side of the root of the cilium." If, now, we suppose these "*two spines*" to be the right and left profiles of a membranous, cylindrical collar, such as I have described in *Leucosolenia*, then it follows that the monociliated sponge-cell of *Spongilla* is like that of the former. That Carter did not always find these "two spines," may be explained by the fact that the membranous collar, as I am inclined to believe the "spines" to be, was retracted, since I have frequently observed this to happen in the case of *Leucosolenia* when it was disturbed.

each other, at or about the middle of the body. When fully expanded, they are from one-fifth to one-fourth the diameter of the monad, and have a perfectly globular shape. In appearance, and manner and rate of systole and diastole, they resemble those of *Codosiga* so closely that the former might be substituted for the latter with scarcely a chance for a detection of the change. As the rate of systole of each vesicle, which is once in half a minute, was observed directly through the undisturbed layers of the colony, and moreover at the edge of the ostioles, there need be no hesitation in accepting the record as that of the normal measure of pulsation.

§ 11. *Anthophysa Mülleri*, Bory. Pl. VI. figs. 47–61; Pl. VII. figs. 62, 63.

A description of this infusorian, but without illustrations, has already been published in the 'Annals' for December 1866. In order to carry out the object of this memoir to its fullest extent, I propose here to make quite large extracts from this paper, and also to add a number of figures, both for the better understanding of the character of the animal and for the sake of comparison with others which are illustrated in the accompanying plates.

The mononematous *Flagellata* which are described in the foregoing pages (§§ 1–10) are connected with the heteronematous forms through two diverse lines; or, rather, they are closely allied to two different types of *diversiflagellate* Infusoria, of which *Anthophysa* is an example of one type, and *Anisonema* (§ 13) a representative of the other—both of the flagella of the former being proboscidiform, and, of the latter, one being gubernaculiform and the other proboscidiform. The intimate alliance of *Anthophysa* with *Monas* may be best expressed by saying that the former is a *Monas* modified by the addition of a comparatively minute *cilium*, which is affixed to the head near the *flagellum*.

Anthophysa Mülleri, Bory (*Epistylis? vegetans*, Ehr.), is quite common among freshwater plants, such as *Myriophyllum*, *Ceratophyllum*, and *Utricularia*, and adheres to their filiform leaves like an irregular, floccose, brownish deposit.

" Under a low magnifying-power this floccose matter appears to consist of clusters of very jagged, irregularly branching and contorted, semitransparent, intertwined stems, and projecting tapering and flexible twigs (*pd*). Each of the tips of the latter sustains a single, more or less globose mass of spindle-shaped bodies (*md*), which radiate from a common centre of attachment, and are kept in a constant agitation by the spasmodic jerks of a long, stout, usually rigid, arcuate filament (*fl*), with which the free end of each one is endowed. The whole bristling mass revolves alternately from right to left and from left to right, whirling upon its slender pivot with such a degree of freedom that one might almost suspect that it merely rested upon it, and had no truer adhesion to it than the juggler's top to the end of the *bâton* upon which it spins. The largest of these twirling groups contains as many as fifty fusiform bodies; but most frequently not more than half that number are grouped together; and from this they vary in decreasing numbers down to only one or two (fig. 48) upon each filamentous twig. In the last instances the bodies are comparatively quiet, scarcely moving out of focus at each spasmodic twitch of the arcuate filament. On this account, and because they offer an unobstructed view, the latter are by far the most available as objects for the investigation of their internal organization.

"The relationship of the individual monads to the whole colony must, however, be studied where they are more numerously congregated, since, as will be shown presently, each monad sustains a definite relation to every other one and to the twig to which it is attached."

"*Form &c.*—The adult monads (figs. 47, 48, *md*) have a truncate fusiform shape, and are slightly but quite appreciably flattened on two opposite sides, so that, in an end view, they appear to be broadly oval transversely. The attached end tapers gradually to a point; and on this account it is difficult to determine where the body ends and the twig begins. All of the members of a group radiate from a common point of attachment, to which they adhere by their tapering filamentous ends (fig. 48, pd^1). The free end is truncate; but one corner of it (as if in continuation of the line along which the opposite flattened sides meet) projects in the form of a rather blunt triangular beak (*lp*). At the inner edge of the base of this beak lies the mouth (*m*), to which the former, as frequent observation has proved, acts as a lip or prehensile organ when food is taken into the body. The prevailing tint is a more or less uniform light gamboge, without the least trace of an eye-spot of any colour.

"A most singular uniformity prevails in the arrangement of the several members of a group. Each monad (*md*) is attached to its mooring in such a position that its flattened sides lie parallelwise with those of its nearest neighbour; and the beak (*lp*) projects from that corner of the head which is most distant from the twig (*pd*). To give a full idea of the peculiarity of this arrangement, it must be stated here that the rigid, arcuate, spasmodically twitching filament (*fl*) mentioned above is attached close to the mouth (*m*), and invariably curves away from the beak, and consequently always towards the pedicel (*pd*) of the colony."

"*Prehensile organs.*—The only motile organs which this animalcule possesses are preeminently prehensile in character; and their apparent appropriation to the office of propulsion, when a colony breaks loose from its attachment, I can scarcely doubt is an accidental one, inasmuch as the arcuate cilium continues its spasmodic twitching without any apparent deviation from its usual mode of action.

"There are two cilia, of very unequal size, attached to the truncate end of the body. The larger one of these has already been mentioned casually, as a *rigid, arcuate filament* (*fl*). It does not taper, but has a uniform thickness from base to tip, and is about half as long again as the body. It arises near the base of the triangular beak (*lp*), but appears to be separated from the latter by the intervening mouth (*m*). When quiet, it appears like a bristle, and projects in a line with the longer axis of the body—at the base bending slightly toward the beak, and then sweeping off in a moderate but distinct curve in the opposite direction, so that on the whole it presents a long, drawn-out sigmoid flexure. The plane of this curve lies in strict parallelism with the plane of the greater diameter of the body; in fact it may be said to be a direct continuation of it. It does not appear to have the character of a *flagellum*, except when assisting the smaller cilium (fl^1) to convey the food to the mouth; and then it lays aside its rigid deportment, and assumes all the flexibility and wavy vibration of the prehensile organ of an *Astasia.*

"*The smaller cilium* (fl^1) is an excessively faint body, and almost defies the detective powers of the highest objectives. This is partly due to its almost incessant activity; for when it is quiet or nearly so (which happens when food is passing into the mouth), it becomes comparatively quite conspicuous under a one-eighth-of-an-inch objective. It is scarcely as long as the greater diameter of the truncate end of the body. It arises close to the base of the larger cilium (*fl*); but whether on the right or left, or nearer or more distant from the mouth than the latter, cannot be said positively. Most frequently it was observed to be flexed in the same direction as its companion; and occasionally it seemed to be quite evident that it was attached nearer to the mouth than the latter. It is highly flexible, and vibrates with great rapidity in what appears to be a gyratory manner.

"*The mouth.*—This organ is never visible except when food is passing through it (figs. 50, 51, *m*). It then may be seen that it lies close to the beak, which acts as a sort of lip by curving over the introcepted particles as they pass into the body. The mouth is highly distensible, at times allowing particles as wide as two-thirds the greater diameter of the body to pass in without any apparent extra effort (fig. 51, *m*). It seems undeniable that it possesses discriminative powers in regard to the quality of its food. This one may readily judge of for himself by seeing the unerring precision with which the particles of floating matter are thrown, by the spasmodic incurvature of the larger flagellum, against the mouth, where, if they are not swallowed, they are detained but for an instant by the smaller cilium, quickly adjudged to be worthless, and then thrown off with a twirl of the organ which held them in temporary abeyance. If, however, the captured morsel proves to be agreeable, the larger cilium (fig. 47, *fl*) assists the operations of the smaller one (fl^1) and the lip, by abruptly bending itself at its point of attachment and laying its basal part across the food, pressing it into the mouth, while the terminal portion is kept in a constant wavy vibration, and curved towards the posterior end of the body. This is usually done in three or four seconds; and then the cilia return to their usual positions, while the introcepted edible passes towards the centre of the body, and is there immediately enclosed in a digestive vacuole (fig. 51, *d*). For a while the food dances about in this vacuole with a very lively motion, but finally it subsides into quietude.

"*The contractile vesicle* (*cv*).—There is a twofold difficulty in discovering the presence of this organ. In the first place, it is comparatively quite small; and, secondly, it pulsates so slowly that it is very rarely possible to see it contract twice in succession between any two of the abrupt lateral deviations of the body which the spasmodic twitchings of the arcuate flagellum produce. On this account it has not been possible to determine the precise rate of its systole and diastole. It seems to contract from three to four times a minute. It lies near the surface, about halfway between the two ends of the body, and nearly midway between the two extremes of its greater diameter. At the completion of its *diastole* it has a circular outline, and appears like a clear colourless vesicle in the midst of the yellowish tissue of the body. Upon contraction it disappears, and leaves no trace of its presence. The *systole* progresses slowly, as in *Anisonema* (*A. sulcatum*, Duj.?, and *A.* nov. sp. [*A. concavum*, § 13]), *Cyclidium* (*C.* nov. sp.), and *Phacus pleuronectes*, Duj., and in this respect contrasts strongly with the same process in *Heteromita fusiformis*, Jas.-Clk., *Astasia tricophora*, Clap. (§ 12), and *Cryptomonas* (*C.* nov. sp.), in which the last half of the systole is very abrupt and marked.

"*The stem.*—In addition to what has already been said of the general appearance of this part of the organism, it may be added that the older and basal portions (fig. 63) of the branches are flat, and have a distinct longitudinal irregular striation, to all appearance made up of the older, laterally agglutinated twigs. The youngest, terminal portions (fig. 47, *pd*) of the branches which, under the name of twigs, have been described in this paper as the immediate supporters of the colonies of monads, are evidently tubular (fig. 62). They appear to be as flexible as a spider's thread, and are usually quite irregular in outline, and in the calibre of the canal which permeates them. The wall of these tubular twigs is quite thick, and is alike rough on the exterior and interior faces. The substance within the tubes appears homogeneous, but whether it is solid or fluid could not be determined. The oldest part of the stems is of a reddish-brown colour; but as they taper off into branchlets they gradually assume a gamboge-colour, and finally terminate in scarcely coloured twigs.

" *Reproduction* by fissigemmation (figs. 52–61) is the only method of propagating individuals which I have observed. As a preliminary to this process the monad gradually loses its fusiform shape, and assumes at first an oval contour, and finally becomes globular (fig. 52). During this transition, both of the prehensile cilia (*fl*, fl^1) become much more conspicuous than usual; and the body developes a closely fitting hyaline envelope (*h*) about it, thus passing into a sort of encysted state. The contractile vesicle (*cv*), however, does not seem to cease its pulsations during this period, and moreover it becomes quite conspicuous. This arises mostly from the fact that the body is in a nearly quiet state, and allows the observer to obtain a prolonged and undisturbed view of it. Unfortunately the rate of the pulsations of this organ was not ascertained when the following observations were made, because the whole time was occupied in watching and drawing the various and rapidly changing phases of self-division.

" After the body assumes a globular shape, as above-mentioned, both the larger and smaller cilium seem to be undergoing a change, and become indistinct in outline. Presently two larger flagella (fig. 53, *fl*) burst upon the view, apparently by the longitudinal splitting of the previously single one of the same kind, and rapidly separate from each other by the broadening of the body, leaving between them the smaller cilium. The latter at this time appears much thicker than usual, and seems to be composed of two closely approximated parallel threads (fl^1). By this time the contractile vesicle has also divided into two, which lie closely side by side.

" At this moment the time noted in one series of observations was 2.30 P.M. By 2.35 P.M. (fig. 54) the larger flagella (*fl*) had separated still further, and the smaller cilium had split into two (fl^1) very conspicuous filaments, as yet, however, attached to a common point of the body. From this time forth to the completion of the process of fissigemmation all of the cilia kept up a slow vibration, in which they undulated from base to tip with a sort of snake-like motion. By 2.45 P.M. (fig. 55) the body had become quite appreciably broader than long, the contractile vesicles (*cv*) were widely separated, and the smaller cilia had left between them a considerable space, and each one had approximated quite near to the base of a larger flagellum. At 2.50 P.M. (fig. 56) the body had become nearly twice as broad as long, and the space (e^1) between the two pairs of cilia was nearly twice as great as in the last phase, and considerably depressed in the middle, so that the body had a broadly cordate outline. By 2.52 P.M. (fig. 57) the posterior end of the body (at a point a little to one side of the spot where it was attached to the pedicel) was also slightly indented, so that in outline it presented a guitar-shaped figure, each rounded half of which bore a pair of unequal cilia, and contained a contractile vesicle. In one minute more the contraction had increased to such an extent that the body was divided about halfway through (fig. 58). By 2.54 P.M. (fig. 59) the animal had a dumb-bell shape, and the pedicel (*pd*) was attached to one of the segments near the point of constriction. Still the process went on very rapidly, and by 2.55 P.M. (fig. 60) the new bodies were widely separated, but still attached to each other by a mere thread. At 3 P.M. (fig. 61) the body which was attached to the pedicel was left alone, and its companion swam away to seek a new attachment and build up its stem.

"To the last moment the hyaline envelope remained about the segments, and in fact so long afterwards that time and circumstances did not allow me to ascertain its final disposition. I would remark, however, that when the ovate bodies of the half-grown monads (fig. 49) are contracted temporarily into a globular shape, they appear identical (excepting that they lack the hyaline envelope) with these recently fissed forms. In all probability, therefore, the latter lose their envelope and assume the shape of the former.

"As to the development of the stem, I think it quite certain that it grows out from the posterior end of the body. The best proof of this is, that I have frequently found a monad (especially in the condition of the one which I described above as breaking loose from its companion) nearly sessile upon a clean spot, and attached by a very short, faint, film-like thread. From this size upward I have no difficulty in finding abundant examples as gradually increasing in diameter as they did in length—thus furnishing a pretty strong evidence that the stem grows under the influence of its own innate powers, and is not, therefore, a deposit emanating from the body of the monad, except, perhaps, as far as it may be nourished by a fluid circulating within its hollow core."

[To be continued.]

XXVIII.—*Observations on the Fur-Seals of the Antarctic Seas and the Cape of Good Hope, with the Description of a new Species.* By Dr. J. E. Gray, F.R.S., V.P.Z.S.

Further research and additional specimens have shown that, with all the attention I had bestowed on the Seals which had been named *Phoca falklandica*, I have some additions which require to be made to my former paper.

Capt. Abbot assures me that there were only three kinds of Seals found in the Falkland Islands when he was there, about ten years ago,—viz. (1) the Sea-Bear (*Otaria jubata*), (2) the Fur-Seal (*Arctocephalus nigrescens*), which are Eared Seals, and (3) the Sea-Leopard (*Stenorhynchus leptonyx*), which is an Earless Hair-Seal.

According to Pernetty (Voy. aux îles Malouines, p. 202), Sea-Lions or Sea-Elephants (*Morunga elephantina*) were found there in his time: they may have been driven away or all destroyed by the sealers; and some other species that formerly lived in the islands may have shared the same fate. If that is the case, the beautiful Fur-Seal in the British Museum which I have named *Arctocephalus falklandicus* is not now found in the Falkland Islands, though it was received as a Seal from there. On my showing Mr. Bartlett the specimen, he brought me a furrier's small imperfect skin of the same species, which he had purchased of a fellmonger, who assured him that such Fur-Seal skins were only received from the arctic part of the Pacific Ocean. If this be true, the skin was probably that of a young individual either of Steller's Sea-Bear (*Eumetopias Stelleri*) or of a species allied to it, which, as I mentioned in my former paper, are the only Seals that have such a close, soft, elastic fur.

The statement that the Museum specimen of *Arctocephalus falklandicus* was not a Falkland but a northern species renders it necessary that further research should be made to determine the two specimens in the Museum of Science and Art at Edinburgh, which were, according to Mr. R. Hamilton, conveyed to